Competition Overview

"Future missions to the Moon, Mars and beyond will require innovative options to shelter our explorers, and we won't be able to carry all of the materials with us from Earth. NASA's 3D-Printed Habitat Challenge, a Centennial Challenges competition, seeks ways to create or develop the technologies needed to create such habitats on-site, and challenges citizen inventors to lead the way…" – nasa.gov/3DPHab/

Through four distinct competition phases, NASA's 3D-Printed Habitat Challenge will stretch the body of knowledge surrounding 3D-printing applications. Taking place 2015-2017, Phase 1 and 2 challenged industry and academia to develop conceptualizations of the first Martian outpost and 3D-print a column, beam, and small roof section using materials found on Mars. Now in Phase 3, we are taxed with fully designing a constructible Martian habitat and 3D-printing a foundation, walls, and a 1:3 scale habitat…all in under 16 months.

Challenge Specifics

Phase 3 of NASA's 3D-Printed Habitat Challenge is further divided into two sub-competitions. The Virtual Design Competition is devoted to the design and modeling of a Martian habitat feasible of construction via 3D-printing. The model must meet Levels of Design (LOD) comparable to terrestrial construction, while also satisfying rules specific to this competition and all NASA regulations regarding space and lunar habitats.

The 3D-Printed Construction Competition is devoted to the design of a 3D-printer capable of printing large structures using concrete, developing a concrete mix using Mars- (and/or mission)- relevant materials, and then printing a 2-meter × 3-meter foundation, 1.5-meter high wall section, and 1:3 scale model of the habitat designed in the Virtual Design Competition. There are also several additional printed samples to be submitted for compression, freeze/thaw, and other technical tests.

Penn State Team competing in NASA's 3D-Printed Habitat Challenge Phase 2, Level 3 (roof section) Printing Competition in 2017. Image courtesy of NASA HQ Photos.

Our Plan

We plan to approach this challenge as several parallel competitions. Rather than proceeding from habitat design, to material design, to 3D-printer design, etc, we are having sub-teams investigate each challenge aspect simultaneously. While from initial perspective this challenge appears of significant difficulty, Northwestern is in a prime position to perform successfully. In past years, Northwestern students and faculty have investigated the feasibility of Martian regolith as a building material and developed one of the first Martian concretes. Northwestern Mechanical Engineering has numerous faculty working on additive manufacturing and a team of students recently developed a working concrete 3D-printer. In addition, the Earth and Planetary Sciences Department sets Northwestern at a significant advantage due to the number of Mars experts at such easy access.

The Team

Northwestern's 3D-Printed Martian Habitat Team comes from a greatly varied background; not only is the project interdepartmental, but it also spans multiple colleges. Even in this early stage, the team is composed of students and faculty from the Department of Chemical and Biological Engineering, Department of Civil & Environmental Engineering, Department of Earth and Planetary Sciences, Department of English, Department of Materials Science and Engineering, Department of Mechanical Engineering, Department of Political Science, and the Medill School of Journalism.

Along with the diverse backgrounds, we also bring a wide variety of expertise; with 17 students (ranging from Undergraduate to PhD), 8 faculty members, and 1 staff member. In addition, we have partnered with Skidmore, Owings & Merrill (SOM), one of the world's largest and most influential architecture, engineering, and urban planning firms, to assist in design and all areas of the competition.

Leading our team are the following individuals:

Gianluca Cusatis, PhD	**Matthew Troemner**
Faculty Advisor	Student Project Manager
Associate Professor	PhD Student
Civil and Environmental Engineering	Civil and Environmental Engineering

Timeline

- 2018 February 15: Registration Closed (Official Competition Kick-off)
- 2018 May 16: Virtual Construction Level 1 (60% Habitat Design)
- 2018 July 11: Construction Level 1 (3D-Printed Foundation)
- 2018 December 5: Construction Level 2 (3D-Printed Walls)
- 2019 January 16: Virtual Construction Level 2 (100% Habitat Design)
- 2019 April 29: Construction Level 3 (3D-Printed Subscale Habitat)